2008 BIANNUAL REPORT

GAZOS CREEK MARBLED MURRELET MONITORING PROGRAM

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Prepared by:

STEVEN SINGER
STEVEN SINGER ENVIRONMENTAL AND ECOLOGICAL SERVICES
218 Nevada Street
Santa Cruz, CA.
95060

and

TOM HAMER
HAMER ENVIRONMENTAL
P.O. Box 2561
Mt. Vernon, Washington
98273

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INTRODUCTION

This is a report of the 2008 survey results obtained as part of the multi-year monitoring program of Marbled Murrelet (*Brachyramphus marmoratus*) use of Gazos Mountain Camp and the Gazos Creek Watershed in the central Santa Cruz Mountains. The Santa Cruz Mountains provide breeding habitat for the Central California population of Marbled Murrelets. Gazos Creek is located in the central, western Santa Cruz Mountains and discharges into the ocean at a point about midway between Santa Cruz and Half Moon Bay. It is one of only four major flight corridors used by murrelets in the Santa Cruz Mountains. The monitoring program includes radar surveys in the lower canyon in alternate years, and annual ground observer surveys at Gazos Mountain Camp. This report contains the results of ground observer surveys conducted in 2007 and 2008, and radar surveys conducted in 2008.

Radar surveys were conducted at the Double Low Gazos site, about 2.0 kilometers upstream of the mouth of Gazos Creek (see map, page 12). Ground observer surveys were conducted in the lower meadow at Gazos Mountain Camp, which is located at the end of pavement of Gazos Creek Road, about 4.2 kilometers upstream from the mouth of Gazos Creek (see map, page 12). Survey stations are described in Singer and Hammer (2001 and 1999).

History of the Gazos Creek Canyon Monitoring Effort

The monitoring program is sponsored by the Apex Houston Trustee Council, the Sempervirens Fund, and the Oil Spill Prevention and Response Program of the California Department of Fish and Game. It is supported by the California Parks Department and the Pescadero Conservation Alliance. Major funding was provided by the Apex Houston Trustee Council which initiated the monitoring program after it contributed funds toward the purchase of marbled murrelet habitat at Gazos Mountain Camp in the Gazos Creek Canyon.

In 1998 the Apex Houston Trustee Council contributed $500,000 to the Sempervirens Fund toward the purchase of the 110-acre Gazos Mountain Camp property. The Sempervirens Fund subsequently purchased the Gazos Mountain Camp property for $1.5 million. The property includes a 10-acre old-growth stand, a second-growth stand with some residuals, a large area of young second-growth, and a 12-acre developed camp area that does not contain potentially suitable murrelet nest trees, but does have buildings and other facilities. It was understood that the old-growth area would be preserved as nesting habitat for the marbled murrelet and the developed portion of the property would be used for environmental education, scientific studies, or some other use that would be appropriate for the setting and compatible with both the purpose of the park and the intentions of the Sempervirens Fund donors, whose contributions allowed purchase of the property. To be sure that uses on the developed portion of the property did not harm any nesting marbled murrelets, a set of habitat management guidelines was prepared by the Sempervirens Fund and the Apex Houston Trustee Council in 1999 (Singer, 1999). In 2001, the Sempervirens Fund sold the property to the California State Parks Department as an addition to Butano State Park. The 12-acre developed portion of the Gazos Mountain Camp property was then leased to the Pescadero Conservation Alliance (PCA) which plans to operate a scientific field station, environmental education programs, and conservation efforts to protect and enhance murrelets breeding on the 110-acre parcel or lands nearby.

A condition attached to the Council's contribution was that there be an on-going monitoring program of murrelet use at Gazos Mountain Camp and the Gazos Creek Canyon, which is an important

murrelet flight corridor to Gazos Mountain Camp and other breeding areas further inland. An M.O.U. was developed between the Apex Houston Trustee Council, the Sempervirens Fund, and Steven Singer Environmental and Ecological Services to conduct the monitoring effort – an effort that utilized both ground observer surveys at Gazos Mountain Camp and radar surveys in Gazos Creek Canyon.

The monitoring program was developed in 1998 and 1999 and fully implemented in 2000. Ground observer surveys, six per season, were used to determine general murrelet detection levels and types of murrelet activities near the old-growth stand. Ground surveys can provide evidence of nesting through the detection of occupied behaviors, and more specifically, the detection of single silent murrelets flying below canopy during the incubation exchange period. Funding for that effort expired in 2004, but the surveys have continued on a pro-bono basis by Steven Singer Environmental and Ecological Services. Biannual radar surveys are conducted in order to monitor the number of murrelets using the Gazos Creek Canyon flight corridor.

METHODS

At Gazos Mountain Camp ground observer surveys were conducted in accordance with the Pacific Seabird Group protocol (PSG Marbled Murrelet Technical Committee 1994) and used to determine general murrelet detection levels and types of murrelet activities in the meadow across from the old-growth stand. In Gazos Creek Canyon, downstream from the Camp, ornithological radar was used to ascertain a watershed-specific index of murrelet abundance that could be used to determine changes in murrelet use and total numbers over time (for example, see Cooper et al. 1999a, b, Singer and Hamer 1999). Unlike the PSG ground observer protocol surveys that detect artifacts of the birds like calls or briefly observed flight segments, radar surveys actually sample individual birds and can provide an index of the population size that can be monitored from year to year to detect changes in bird abundance (Cooper et. al., 1999 a, b). The initial goal of the monitoring program was to determine if a 5% or greater change occurred between 2000 and 2010 in the number of murrelets using the Gazos Creek Canyon Flyway. Unfortunately, that goal was based on an under-estimate of the natural year-to-year variability that occurs in the number of murrelets flying inland. As discussed later in this report, the new goal of this effort is to be able to detect a 10% or greater change, if present, by 2012.

Radar Surveys

Seven radar surveys were conducted in early July of 2008 at the Double Low Gazos site, about 2.0 kilometers upstream of the mouth of Gazos Creek and about 2.0 kilometers downstream of Gazos Mountain Camp (see map on page 12). Radar surveys were conducted using a modified marine radar system with the antenna mounted onto the camper roof of a 4x4 Ford pickup truck. The radar system was a Furuno model FCR-1141, 10-kW, X-band radar unit with a 2 meter long slotted wave guide array antenna that is sensitive enough to detect birds at a distance of up to 1.2 km. Pulse length could be set at 0.08, 0.6, or 1.0 *u* sec, and the range was set at 0.5 nautical miles. The radar beam had a vertical span of 25 degrees and a horizontal beam width of 2 degrees.

Each radar survey started 75 minutes before sunrise, lasted 2 ½ hours, and followed the protocol for radar surveys provided in the appendix to the Pacific Seabird Group's "Methods for Surveying Marbled Murrelets in Forests" (Cooper and Hamer 2000). The time, direction, speed, and flight path of each murrelet or cluster of murrelets was recorded by a trained radar biologist and a videotape of the radar screen was kept for a permanent record. Murrelet detections on the

radar screen were distinguished from echoes made by other bird species on the basis of echo size, flight speed, and flight behavior. For a detection to be labeled as either “in-bound” or “out-bound”, the bird’s flight path had to be within 45 degrees of a line running along the long axis of the canyon. Murrelets flying in other directions or circling were categorized as "other".

Ground Observer Surveys

During both 2007 and 2008, six ground observer protocol surveys were conducted in July (or the few days immediately before or after) in the lower meadow area of Gazos Mountain Camp (see map on page 12). All ground observer surveys started 45 minutes before sunrise and lasted two hours and were conducted according to the Pacific Seabird Group protocol that was current when the project was initiated (PSG Marbled Murrelet Technical Committee, 1994).

RESULTS AND DISCUSSION

Background Information - Status of the Central California Marbled Murrelet Population

In an unrelated study, Peery et al. (2008) conducted at-sea surveys of marbled murrelets offshore of the Santa Cruz Mountains during the 2008 breeding season. They reported a current population size of only 174 birds, which was a decrease of 54% since their 2007 surveys, and a decline of 74 – 76% since their 2003 surveys. They predicted the extirpation of the central California murrelet population within the lifespan of the existing cohort of birds [i.e., about 10 – 15 years] (Peery et al., 2008).

Radar Surveys in the Gazos Creek Canyon

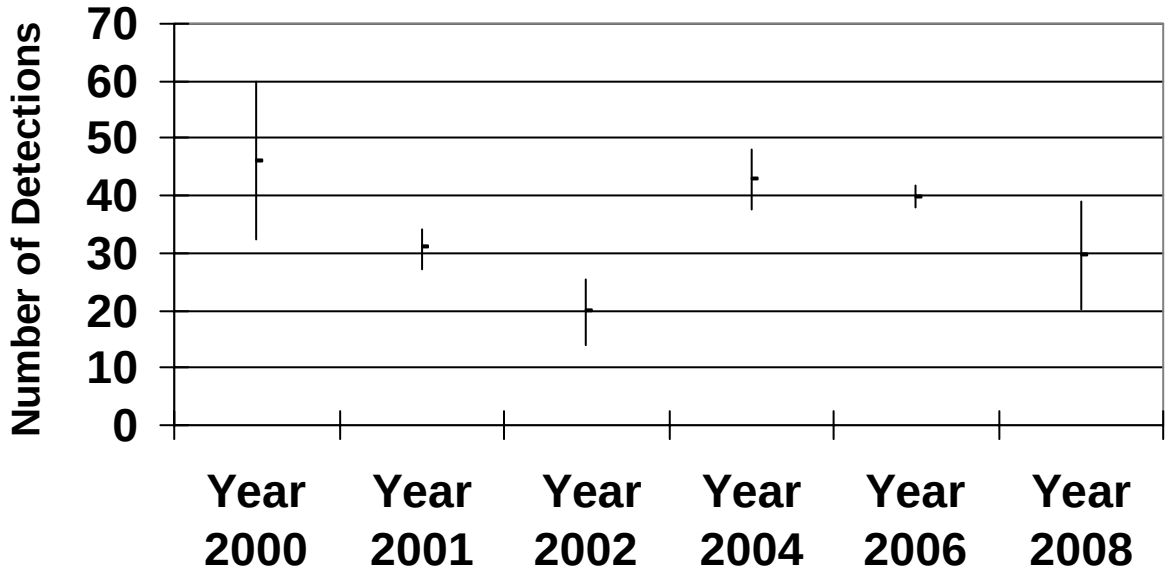
Radar surveys conducted in this study do not show a dramatic decrease in the number of murrelets using the Gazos Creek Canyon flight corridor. A statistical review of the radar data (discussed later) found only a possible small decline in murrelet numbers (not greater than 20%) since project initiation in 2000.

Seven radar surveys were conducted during July of 2008 at the Double Low Gazos site downstream of Gazos Mountain Camp. The total number of murrelets detected by radar in 2008 was 207 which were less than the 279 detections tallied in 2006 and the 300 detections tallied in 2004. However all of these totals are higher than the 138 detections recorded in 2002. Results of the 2008 surveys are shown in Table 1 and compared with previous years in Figure 1.

Table 1. Year 2008 results of radar surveys for murrelets at Double Low Gazos. Values for the mean, standard deviation (s.d.), and coefficient of variation (C.V.) are given in the bottom rows.

Date	% Overcast	Total Number Of Detections	In-Bound Detections	Out-bound Detections	Other Detections
7/8/08	0	27	7	12	8
7/9/08	0	20	2	6	12
7/10/08	0	22	0	17	5
7/11/08	0	22	4	8	10
7/12/08	100	32	2	13	17
7/13/08	100	40	5	10	25
7/14/08	100	44	8	15	21
Totals		207	28	81	98
Mean		**29.57**	**4**	**11.57**	**14**
s.d.		9.44	2.88	3.86	7.25
C.V.		0.3195	0.7217	0.3342	0.5184

Figure 1. Mean Number of Total Radar Detections, 2000 - 2008



(Note: Error bars represent one standard deviation)

It is known that the number of individual murrelets flying inland varies from year to year due to factors other than population change (McShane et al. 2005, Peery et. al. 2004a; Peery et al. 2004b). In a two-year study, Peery et. al. (2004a) placed radio-tags on 46 murrelets and found that, within their tagged sub-populations, non-breeders didn't fly inland as often as breeders, and that the proportion of non-breeders in the regional population varied from year to year. It is generally known that there are several other sources of variability in the number of murrelets flying inland each year. These include local changes in prey availability at sea that alter the extent or timing of the breeding effort, changes in the location of ocean staging areas that influence the flight paths used by birds flying inland, and changes in the elevation of bird flights within inland flight corridors due to weather conditions or other factors. If murrelets were flying low enough they could pass below the portion of sky scanned by radar. Some or all of these factors may contribute to the variability shown in Figure 1.

Statistical Analysis of Radar Data

A biostatistician was hired in December of this year to undertake a regression-based analysis of the radar data to date (Verschuyl, 2008). When looking at repeated measures regression over the six sampling years from 2000 to 2008, he found an insignificant decline (R-squared = 0.005). However, when he looked at the data set from 2004 to 2008 alone, he found a significant negative slope (R-squared = 0.67). The following two paragraphs are taken from his report.

> A power analysis was conducted using the existing data to assess how many additional years of survey would be necessary to detect different magnitudes of population trends with a range of power [see table below]. The statistical tests were run with an alpha value (accepted type one error rate) set at 0.05. The power analysis utilized the ratio of within (daily) to between year variance in the 6 existing years of data to determine how many additional years would be necessary (at two year spacing) to detect whether or not there is a certain trend in population.
>
> Based on the power analysis and regression results, it seems wise to continue sampling for 2 additional years to determine whether or not there is a 10 % annual population decline (with 75% power). This would entail sampling efforts in 2010 and 2012. In addition, the additional sampling will allow us to assess whether the 2004-2008 trend continues.

Table 2. Additional years of data collection necessary (beyond 2008) to detect different magnitudes of population trends with a range of power when looking at the total number of targets detected (adapted from Verschuyl, 2008).

	POWER			
Detectable Population Trend	**75**	**80**	**85**	**90**
5%	7	7	8	9
10%	2	3	3	4
20%	0	0	0	0

Ground Observer Surveys at Gazos Mountain Camp

Six ground observer surveys were conducted in 2007 and 2008 and the results are presented in Tables 3 and 4, respectively. In 2008, the mean number of total detections, visual detections, occupied behaviors and detections of single silent birds below canopy height (SSBBC) were all significantly greater than in 2007. Additionally, on July 16, 2008, 128 detections were tallied which is the highest number of detections recorded since surveys began in 1998.

Table 3. Year 2007 results of ground observer surveys for murrelets at Gazos Mountain Camp. Values for the mean, standard deviation (s.d.) and coefficient of variation (C.V.) are given in the bottom rows.

Date	**% Overcast**	**Number of Detections (# Visuals)**	**Number of Occupied Behaviors**	**Number of Single, Silent Birds Below Canopy**
6/29/2007	30 - 66	20 (4)	2	0
7/11/2007	100	40 (12)	8	5
7/14/2007	0	11 (0)	0	0
7/20/2007	10 - 50	38 (7)	5	1
7/29/2007	25 - 85	59 (30)	27	12
8/1/2007	66 - 100	19 (14)	13	2
MEAN		**31.17 (11.16)**	**9.17**	**3.33**
s.d.		17.77	9.87	4.63
C.V.		0.57	1.08	1.39

Note: Occupied Behaviors include circling above canopy.

Table 4. Year 2008 results of ground observer surveys for murrelets at Gazos Mountain Camp. Values for the mean, standard deviation (s.d.) and coefficient of variation (C.V.) are given in the bottom rows.

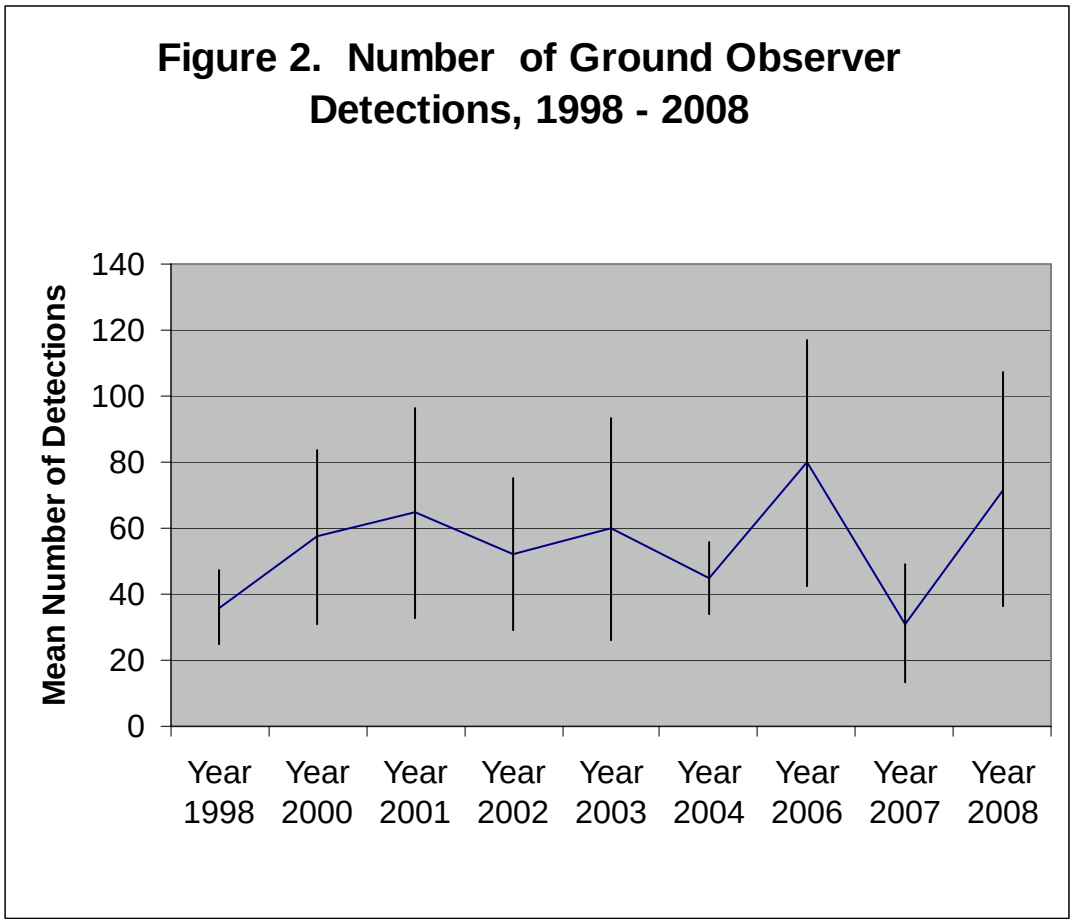
Date	% Overcast	Number of Detections (# Visuals)	Number of Occupied Behaviors	Number of Single, Silent Birds Below Canopy
7/3/2008	0	70 (23)	21	7
7/4/2008	0-66%	70 (33)	33	21
7/6/2008	100-66%	77 (49)	40	6
7/16/2008	100-90%	128 (71)	48	29
7/23/2008	0	70 (33)	20	12
7/26/2008	0	16 (0)	1	0
MEAN		**71.83 (34.83)**	**27.17**	**12.5**
s.d.		35.52	16.77	10.71
C.V.		0.49	0.62	0.86

Note: Occupied behaviors include circling above canopy.

Table 5 shows the mean number of ground observer detections for each year going back to the start of the project in 1998. Also shown are the highest and lowest total detection days for each year. No data are available for 1999 or 2005. Figure 2 shows the mean values of the total detections from 1998 to 2008. The error bars represent one standard deviation.

Table 5. Ground observer detections, 1998 – 2008

Number of Detections	Year 1998	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2006	Year 2007	Year 2008
Highest Day	49	100	105	75	127	59	125	59	128
Lowest Day	18	25	26	25	39	29	25	11	16
Mean	**36.00**	**57.33**	**64.67**	**52.00**	**59.67**	**44.7**	**79.7**	**31.17**	**71.83**



Tables 3, 4, and 5 reveal that there is a very large amount of both day-to-day and year-to-year variation in both the number of total detections and the number of occupied behaviors from 1998 to 2008. This is in agreement with the work of Jodice (1998) who conducted ground surveys at five sites in the Oregon Coast Range on a near-daily basis throughout the season for three breeding seasons. He found there to be high variation in daily activity levels and concluded that the power of ground surveys to detect annual declines in detections of 25 percent and 50 percent were only "very low" and "moderate", respectively; even with nearly 100 replicate surveys per season. Consequently, we are only using ground survey data to determine if nesting, or more correctly, behaviors associated with nesting are occurring, and not to ascertain trends in the number of murrelets using the canyon. Radar surveys are the only appropriate tool for that.

Many observations have shown that the behavior most strongly indicative of nesting in the vicinity is single silent birds seen flying below canopy (SSBBC). Table 6 lists the number of SSBBC detections and occupied behavior detections recorded each day during each survey year.

Table 6. Comparison of the number of occupied behaviors, designated as Occ. Beh., and single silent birds below canopy (SSBBC) detected by ground observers – 1998 through 2008 at Gazos Mountain Camp on each survey day. Results were ranked from high to low by the number of occupied behaviors, which included birds circling above canopy. No data are available for 1999 or 2005.

1998 Occ. Beh. Detects & (SSBBC)	2000 Occ. Beh. Detects & (SSBBC)	2001 Occ. Beh. Detects & (SSBBC)	2002 Occ. Beh. Detects & (SSBBC)	2003 Occ. Beh. Detects & (SSBBC)	2004 Occ. Beh. Detects & (SSBBC)	2006 Occ. Beh. Detects & (SSBBC)	2007 Occ. Beh. Detects & (SSBBC)	2008 Occ. Beh. Detects & (SSBBC)
16 (10)	31 (1)	43 (2)	18 (0)	15 (0)	18 (7)	41 (11)	27 (12)	48 (29)
13 (4)	21 (0)	29 (3)	14 (2)	15 (0)	15 (5)	23 (2)	13 (2)	40 (6)
13 (3)	15 (0)	19 (1)	8 (7)	10 (0)	11 (1)	21 (0)	8 (5)	33 (21)
10 (3)	10 (0)	7 (2)	7 (0)	9 (0)	11 (0)	17 (3)	5 (1)	21 (7)
7 (3)	7 (4)	6 (2)	5 (0)	5 (2)	1 (0)	16 (1)	2 (0)	20 (12)
5 (1)	6 (1)	3 (0)	3 (0)	4 (0)	1 (0)	1 (0)	0 (0)	1 (0)

Note: SSBBC = Single silent birds flying below one-canopy height

When SSBBC detections are observed on all or nearly all survey mornings, as was the case in 1998, 2001, and 2008, it is a strong indicator of likely nesting activity nearby during the survey period. The closest location for nesting would be the hillside old-growth stand across the creek from the meadow. The timing of these below-canopy flights would also be an important consideration, with flights during the early part of the activity period being more likely to represent birds associated with incubation exchanges. In 2008, four of the five days with SSBBC flights had those flights occurring at least 12 minutes before sunrise which is within the normal incubation exchange period. It is possible that the sudden cessation of such flights between 7/23/08 and 7/26/08 signifies the cessation of activity at a nest that had been generating such flights, although this cannot be proven without the actual discovery and direct observation of the nest.

CONCLUSIONS

A comparison of Figures 1 and 2 shows the value of radar surveys over ground surveys if trying to determine the number of murrelets using an area. Both year to year variation and day to day variation are significantly less when using radar (i.e., note the difference in the scale of the Y axis between the two graphs). However ground observer surveys are useful for other reasons. They can provide evidence of nesting at Gazos Mountain Camp through the detection of occupied behaviors and the detection of single silent murrelets flying below the canopy. Radar surveys cannot detect birds flying below canopy in forests with small openings or meadows such as at Gazos Mountain Camp. What radar surveys can do is to provide an index of murrelet abundance in the Gazos Creek Watershed.

The radar data collected to date show that the number of murrelets using the Gazos Creek Canyon flight corridor is either unchanged, or if declining, has decreased by less than 20% since 2000. To determine more precisely (+/- 10%) any changes in murrelet abundance, an additional

year of radar surveys is needed beyond what is already funded and the end of the project will need to be extended from 2010 to 2012.

The recent work by Peery et al. (2008) has generated much concern about Marbled Murrelets in the Santa Cruz Mountains. However, the broad implications of their work may not be realized if the system is a complicated dynamic of source and sink processes associated with population influxes from other areas. DNA work by Hall (pers. comm.) suggests that immigrant birds may not breed locally. If this is the case, at-sea sampling and radar sampling may draw from two different subpopulations of birds; i.e., a resident population of breeding birds and a broader population of resident and immigrant birds found at sea. If that is the case, then at-sea counts might be unduly influenced by year to year movement of immigrant birds in or out of the area.

Although Peery et al. (2008) has stated that "…Marbled Murrelets in central California will almost certainly become extirpated when the current cohort of adults dies", we cannot agree that extirpation of this population is a foregone conclusion. Our results, although limited to only only one of the four major inland flight corridors, do not support the existence of such a dramatic decline. What our results do indicate is that further monitoring efforts of all types should be continued until we have a better understanding of the Central California Marbled Murrelet population.

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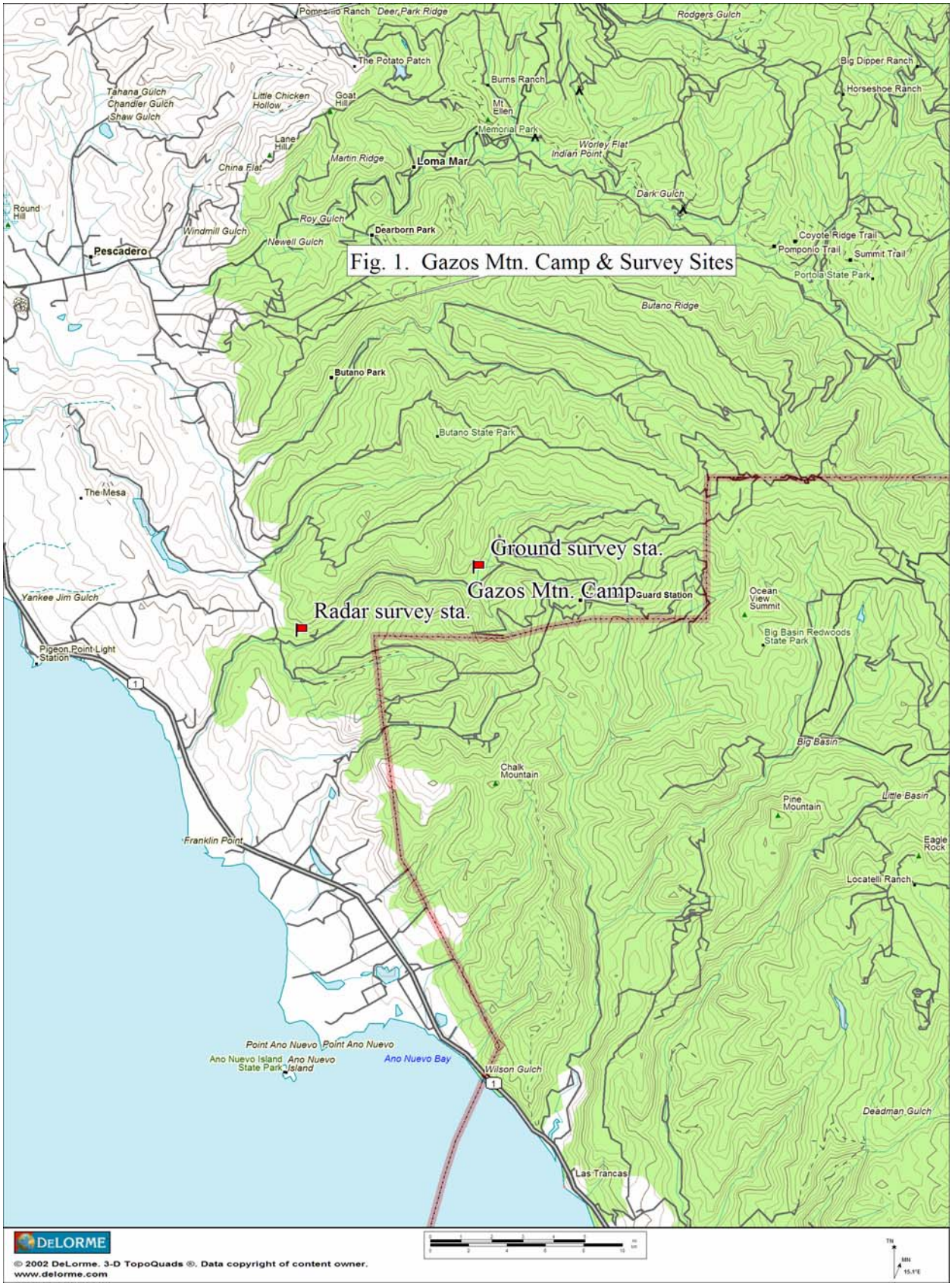
Fig. 1. Gazos Mtn. Camp & Survey Sites
Ground survey sta.
Gazos Mtn. Camp
Radar survey sta.
Pomponio Ranch
Deer Park Ridge
Rodgers Gulch
The Potato Patch
Big Dipper Ranch
Horseshoe Ranch
Burns Ranch
Tanana Gulch
Chandler Gulch
Shaw Gulch
Little Chicken Hollow
Goat Hill
Mt Ellen
Memorial Park
Lane Hill
Martin Ridge
Loma Mar
Worley Flat
Indian Point
China Flat
Dark Gulch
Round Hill
Roy Gulch
Windmill Gulch
Dearborn Park
Newell Gulch
Pescadero
Coyote Ridge Trail
Pomponio Trail
Summit Trail
Portola State Park
Butano Ridge
Butano Park
Butano State Park
The Mesa
Yankee Jim Gulch
Guard Station
Ocean View Summit
Big Basin Redwoods State Park
Pigeon Point Light Station
Big Basin
Chalk Mountain
Pine Mountain
Little Basin
Eagle Rock
Franklin Point
Locatelli Ranch
Point Ano Nuevo
Point Ano Nuevo
Ano Nuevo Island State Park
Ano Nuevo Island
Ano Nuevo Bay
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